RESEARCH, DEVELOPMENT & TECHNOLOGY TRANSFER
QUARTERLY PROGRESS REPORT

Wisconsin Department of Transportation
DT1241 02/2011

INSTRUCTIONS:
Research project investigators and/or project managers should complete a quarterly progress report (QPR) for each calendar quarter during which the projects are active.

WisDOT research program category: ☐ Policy research ☒ Wisconsin Highway Research Program ☐ Other ☐ Pooled fund TPF#		Report period year: 2013 ☐ Quarter 1 (Jan 1 – Mar 31) ☐ Quarter 2 (Apr 1 – Jun 30) ☐ Quarter 3 (Jul 1 – Sep 30) ☒ Quarter 4 (Oct 1 – Dec 31)
Project title: Laboratory Study of Optimized Concrete Pavement Mixtures		
Project investigator: Konstantin Sobolev	Phone: 414-229-3198	E-mail: sobolev@uwm.edu
Administrative contact: Peggy Vanco	Phone: 414-229-5000	E-mail: pvanco@uwm.edu
WisDOT contact: Barry Paye	Phone: 920-492-4116	E-mail: barry.paye@dot.wi.gov
WisDOT project ID: 0092-13-04	Other project ID: PRJ63JN	Project start date: 8/1/2012
Original end date: 1/31/2015	Current end date: 1/31/2015	Number of extensions: 0

Project schedule status:
☒On schedule ☐On revised schedule ☐Ahead of schedule ☐Behind schedule

Project budget status:

Total Project Budget	Expenditures Current Quarter	Total Expenditures	% Funds Expended	% Work Completed
199185	33220	124769	62	65

Project description:

The Wisconsin Department of Transportation (WisDOT) continues to investigate the feasibility of optimization of paving mixtures as a means to improve the engineering properties, lower the required cementitious materials content, reduce cost, and minimize the environmental impacts. Previous research conducted by WisDOT concluded that concrete produced with reduced cementitious materials content had an adequate durability; however, these mixes frequently demonstrated poor workability. As a result, a multi-faceted approach to optimizing mixture proportioning for low-slump mixtures used in concrete pavements is needed for WisDOT to realize the benefits related to the use of lower cementitious materials contents. This approach includes the use of supplementary cementitious materials (SCMs), optimized aggregate gradations, and the use of superplasticizers (high-range water reducing, HRWR admixtures). Current WisDOT practice minimizes the use of portland cement through replacement with SCMs, but does not address the use optimized gradation or superplasticizers. Therefore, additional research is needed to support the development of specifications inclusive of the aforementioned factors to improve the performance and sustainability of concrete paving mixtures used in Wisconsin. This research project evaluates the feasibility of expanding current specifications to incorporate optimized superplasticized concrete in sustainable concrete paving applications.

The goal of this study is to produce guidelines for optimized concrete mix design by evaluating the performance of a range of concrete mixtures. The proposed performance evaluation of optimized concrete will include workability (slump and VB-test), air content, unit weight, compressive and flexural strength, freeze-thaw resistance, and rapid chloride permeability in accordance with relevant AASHTO/ASTM standards. The results of the research will be used to recommend the aggregate gradations and dosage of superplasticizers/HRWR admixtures that will accommodate the use of reduced cementitious materials for the low-slump concrete paving mixtures.

To provide the comprehensive optimization of superplasticized concrete, the proposed project will focus on the following objectives:

1. Develop a detailed, final testing matrix for comprehensive testing of aggregate gradations, SCMs and HRWR admixtures in concrete.
2. Evaluate and compare the composition, microstructural features, and physical properties of different types of cementitious materials essential for their compatibility with HRWR admixtures affecting their performance in concrete.
3. Evaluate the effect of HRWR admixtures on the fresh properties and mechanical performance of concrete.
4. Evaluate the effect of aggregate gradations on the fresh properties and mechanical performance of concrete.
5. Evaluate the effect of SCMs and HRWR admixtures on the stability of air void system, fresh properties, mechanical performance, and durability of concrete.
6. Develop and recommend for practical application an express-method capable of evaluating the performance of SCMs and HRWR admixtures in concrete.
7. Provide Life Cycle Analysis of sustainable optimized concrete paving applications based on the experimental results; submit a final report and recommendations for future work and revision of current specifications.

Progress this quarter

During the 4th Quarter of 2013, 15 batches (106 liter each) with three types of portland cement and SCMs with optimal chemical admixture dosages were produced and shipped to UW-Madison for rapid chloride permeability and freeze-thaw durability testing, which are on the way. These batches were also tested for compressive and flexural strength at 1, 3, 7, and 28 days and will be tested for flexural strength at 90 days and compressive strength at 90 and 360 days. Length change / shrinkage measurements are continued.

Testing of all southern aggregates mixtures was finished. New northern aggregates were ordered and shipped to the University of Wisconsin Milwaukee. The testing of aggregate properties including density, relative density, and absorption of coarse, fine, and intermediate aggregates was accomplished.

Anticipated work next quarter:

Work that is expected to be completed in the next quarter includes finishing the characterization, testing for packing degree, sieve and grading analysis of all new aggregates. Additionally, preliminary concrete mixtures (20 liter volume) with new types of aggregates and previously optimized cements and admixtures, new big batches (106 liter volume) with the same chemical admixture dosages and supplementary cementitious material types will be produced.

Durability tests that will be performed will include rapid chloride permeability and freeze-thaw testing for three sets of cements. Length change measurements due to shrinkage will also be continued.

Also, synchronizing the optimal dosage of chemical admixtures from mortars to concrete mixtures, and correlating early strength of mortar and concrete mixtures will be investigated. This follow-up step will further explore the empirical relationships between the results of express-tests and concrete properties and will evaluate the principal parameters affecting the performance.

The research team will provide the statistical analysis of experimental data; develop the relationships between the experimental factors and compare these with AASHTO/WisDOT/ACI requirements.

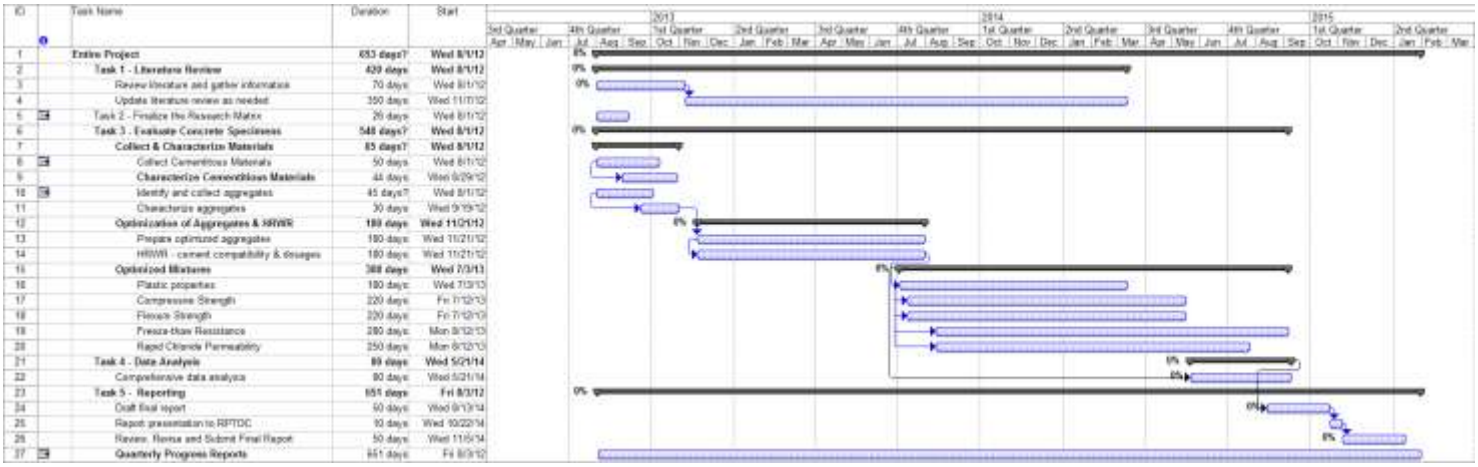
Circumstances affecting project or budget: None

Attach / insert Gantt chart and other project documentation Enclosed

FOR WISDOT USE ONLY

Staff receiving QPR: K. Dinkins	Date received: 1/17/14
Staff approving QPR:	Date approved:

Gantt Chart / Work Time Schedule



ID	Task Name	Duration	Start
1	**Entire Project**	**653 days?**	**Wed 8/1/12**
2	**Task 1 - Literature Review**	**420 days**	**Wed 8/1/12**
3	Review literature and gather information	70 days	Wed 8/1/12
4	Update literature review as needed	350 days	Wed 11/7/12
5	Task 2 - Finalize the Research Matrix	26 days	Wed 8/1/12
6	**Task 3 - Evaluate Concrete Specimens**	**548 days?**	**Wed 8/1/12**
7	**Collect & Characterize Materials**	**85 days?**	**Wed 8/1/12**
8	Collect Cementitious Materials	50 days	Wed 8/1/12
9	**Characterize Cementitious Materials**	44 days	Wed 8/29/12
10	Identify and collect aggregates	45 days?	Wed 8/1/12
11	Characterize aggregates	30 days	Wed 9/19/12
12	**Optimization of Aggregates & HRWR**	**180 days**	**Wed 11/21/12**
13	Prepare optimized aggregates	180 days	Wed 11/21/12
14	HRWR - cement compatibility & dosages	180 days	Wed 11/21/12
15	**Optimized Mixtures**	**368 days**	**Wed 7/3/13**
16	Plastic properties	180 days	Wed 7/3/13
17	Compressive Strength	220 days	Fri 7/12/13
18	Flexure Strength	220 days	Fri 7/12/13
19	Freeze-thaw Resistance	280 days	Mon 8/12/13
20	Rapid Chloride Permeability	250 days	Mon 8/12/13
21	**Task 4 - Data Analysis**	**89 days**	**Wed 5/21/14**
22	Comprehensive data analysis	90 days	Wed 5/21/14
23	**Task 5 - Reporting**	**651 days**	**Fri 8/3/12**
24	Draft final report	50 days	Wed 9/13/14
25	Report presentation to RPTDC	10 days	Wed 10/22/14
26	Review, Revise and Submit Final Report	50 days	Wed 11/5/14
27	**Quarterly Progress Reports**	651 days	Fri 8/3/12